

STRUCTURE, FRACTURE, AND REFRACTURE OF THE PATELLA.

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THE subject of fractures of the patella has attracted many writers, by far the majority of whom have confined their attention to the various methods of treatment, leaving the etiology comparatively untouched. It is, therefore, the latter part of the subject to which I wish to direct attention.

The bone may be broken by direct or indirect violence. It is the fractures that result from the indirect violence that are etiologically the most interesting. It is therefore instructive to examine the conditions as found in a biped and a quadruped, as the latter practically never breaks its patella. In the quadruped the bone exists in the extensor arc over the knee-joint, which is flexed naturally to an angle of about ninety degrees. In consequence, the body-weight will tend to flex the knee, and this tendency must be resisted by the extensor arc, including the patella. If the ligaments bore the strain, flexion of the knee would be limited to ninety degrees, which is not so. The patella must bear a constant strain, and will be a strong bone. In the erect position, the body-weight is transmitted directly from the femur to the tibia, leaving the patella comparatively functionless. As compared with a quadrupedal bone, the human patella is relatively thinner, broader, and has a far wider mesh-work in its internal structure. In examining clinical data, I could find (*Lancet*, October, 1898, and *Veterinarian*, January, 1899) no recorded case in which a quadruped broke its patella by indirect violence, and fractures by direct violence are extremely rare. On the other hand,

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fractures of the patella form, according to Gurlt, 1.4 per cent. of all fractures, and to Makins and Abbott, 2.29 per cent. (St. Thomas's Hospital Reports, 1898, p. 475), and far the majority are caused by indirect violence. As would be expected, the explanations of these points are to be found in the mechani-

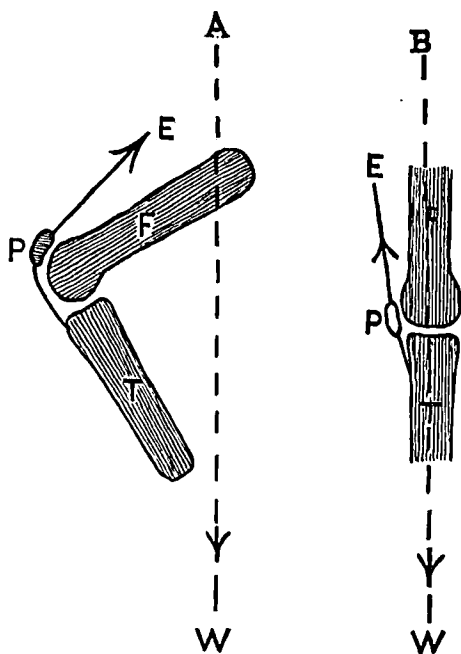


FIG. 1.

cal disposition of the parts. A quadruped has a long ligamentum patellæ that allows the strong patella to be supported throughout its length by the femur; in man, owing to the assumption of the erect attitude, the ligamentum patellæ is short, and the weaker patella lies low down on the femoral condyles, being only in part supported by the femur. In the latter the patella runs the risk, and is frequently broken across the lower end of the femur.

Fractures by direct violence are of very little interest etiologically, and it is the action of indirect violence that offers the most interesting problems. It has therefore been attempted in this paper to separate these two. At the very outset the problem arose as to whether any other than stellate fractures could result from direct violence. The patella is largely peculiar in that when submitted to a blow the femur acts as an anvil, and it is violently compressed between the "hammer" and the "anvil." The femur may be rendered firmer by the knee being flexed at the time of the accident. Under such circumstances, it is difficult to see how anything but a stellate fracture could result, and especially as the "anvil" is convex and presents a somewhat irregular curve. In two directions the above must be modified, viz., the extent of the areas over which the direct violence is diffused or applied, and the relations of the size of the "force-areas" to that of the "contact-areas" between the patella and the femur. To deal with the first of these, it may be stated that the greater the "force-area" the greater the likelihood of stellate fracture and comminution, and *vice versa*. With regard to the second, if the force-area equals or is greater than the contact-area, a stellate fracture will probably result. If, on the other hand, the force-area is less than the contact-area, a transverse or oblique fracture may result, and the smaller the force-area the more likely is this result to be attained. Such an accident as the last is of rare occurrence. There is also another class of fractures called "contusion fractures," where a blow is implanted on the lower end of the patella, the knee being flexed, which breaks the bone higher up. A transverse or oblique fracture will result, and is an example, undoubtedly a very rare one, of the action of indirect violence. Hence it shall be right, or at least most nearly so, in regarding all transverse and oblique fractures as the result of indirect violence. Besides the rare contusion fractures, indirect violence resolves itself into a violent contraction of the quadriceps extensor femoris or a comparatively passive resistance to the action of the body-weight.

In incidentally dealing with corresponding fractures of the

femur and leg bones, far more difficult cases arise for decision, and the figures must be received with caution, as they must be influenced by the personal equation. If they err, as they must, the error will be on the side of there being too many examples of indirect violence, and not too few.

Structure and Refracture.—As the internal structure of the bone is determined by the mechanical conditions under which it exists, sections were cut of human and quadruped patellæ in order to examine the architecture. As this point has been dealt with in a paper read to the Anatomical Society (abstracted in the Proceedings of Anatomical Society, *Journal of Anatomy and Physiology*, April, 1900), February,

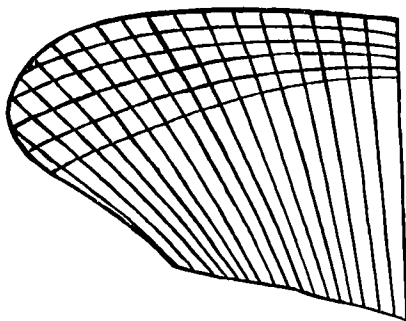


FIG. 2.—Diagram representing the structure of the apex of the human patella.

1900, a brief account only will be given, dealing with such points as may influence fracture. Professor Anderson, following Malgaigne, argued the existence of a diminished textural resistance in the bone, correlating this with the age, sex, and habit of the patient (*Lancet*, 1892, p. 10). Poirier, "Traite d'anatomie," 1897, says that the surrounding layer of compact bone diminishes in thickness as age advances. Beyond these references, nothing could be found that referred to the structure of the patella as likely to influence its fracture.

The accident of fracture by indirect violence is essentially human, and is connected with a relatively broader, thinner,

and weaker bone with a short *ligamentum patellæ* that causes it to lie relatively low on the femoral condyles and more directly over the joint.

On examining a sagittal section of the human patella it is seen that the anterior surface is composed of dense compact bone in which the fibres run parallel to the surface. At the upper end of the bone the compact layer is seen to arise at the insertion of the quadriceps extensor tendon. The deeper

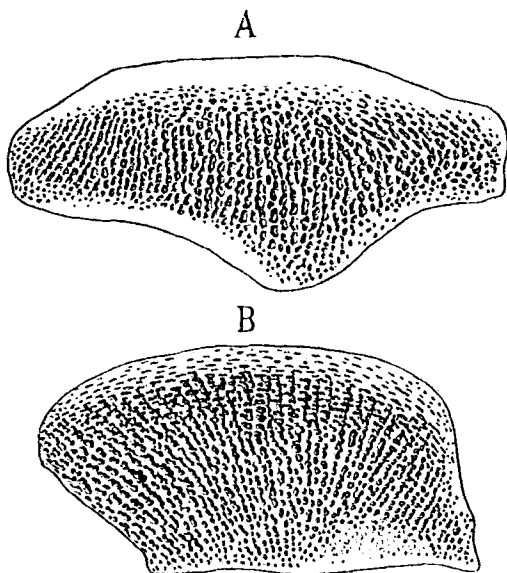


FIG. 3.—A, horizontal section; B, sagittal section of human patella.

fibres of this layer become farther apart from each other, and towards the lower end of the bone or apex fray out to form part of the interlacement in this part. Next to the articular cartilage, a smaller but similar layer of compact bone is seen, which is present in greatest thickness in the upper half of the bone. Connecting these two compact layers are a number of trabeculae. Just above the centre of the bone these connecting fibres are approximately at right angles to the layers of com-

pect bone. As the apex is approached, they become more and more oblique, and in that portion they interlace with the frayed-out fibres of the anterior compact layer forming a mesh-work. At the upper end of the bone a similar but opposite obliquity is observed in the connecting fibres, which is far less extensive than that just mentioned. The connecting fibres are closest together in the upper half of the bone, and towards the apex they are widest apart. At the extreme upper end of the bone they are also less close than at the middle.

The explanation for this architecture is that the fibres in the anterior layer of compact bone represent the lines of traction of the quadriceps extensor muscle; and it is interesting to note that by running over the anterior surface of the bone they gain the greatest leverage that the patella can give them. The connecting fibres represent the lines of pressure of the patella upon the femur. The distribution of the lines indicates that the patella is directly supported by the femur in the upper half of the bone, and that in the lower half the pressure becomes more and more oblique until in the apex the pressure and traction lines interlace, forming the best mechanical arrangement for strengthening a part unsupported by the femur. A similar argument may be drawn from the far shorter range of the oblique fibres at the upper end of the bone, but, comparatively speaking, these are of little importance.

From observation of the internal architecture of the bone, it will be seen that the lower half of the patella is weaker than the upper, and also that, as in the former, the direction of the pressure is oblique, fractures should be most frequent in this region. In order to test this point, I have examined the records of cases of fractured patella which occurred in the St. Thomas's Hospital practice in the ten years, 1890-1899 inclusively. In a number of cases the necessary data are vague, but I was enabled to gain data of 191 cases. These are classified under three headings,—the upper fragment is the larger, about the centre, the lower fragment is the larger. I have found that Hamilton ("Fractures and Dislocations"), on a smaller scale, has adopted this classification, and add his figures to the table.

St. Thomas's. Upper fragment the larger; 72 cases; 37.7 per cent. About the centre, 87 cases; 45.5 per cent. Lower fragment the larger, 32 cases; 16.8 per cent. Total number of cases, 191.

Hamilton. Upper fragment the larger, 22 cases; 48.8 per cent. About the centre, 16 cases; 35.5 per cent. Lower

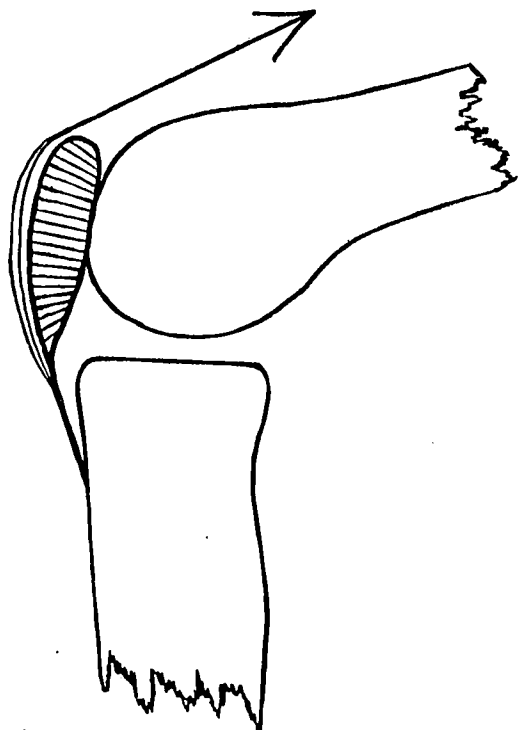


FIG. 4.—Diagram showing pressure and traction lines.

fragment the larger, 7 cases; 15.5 per cent. Total number of cases, 45.

From this table it is seen that fractures about the centre and in the lower half of the bone form no less than 83.2 per cent. of the St. Thomas's cases and 84.3 per cent. of Hamil-

ton's. Hamilton makes fractures in the lower half of the bone more frequent than at the centre, which the St. Thomas's records do not. The former table, being the results of one worker, has an advantage over the latter, which is obtained from the work of many.

Fracture of the patella by indirect violence is really due to an exaggeration of the natural mechanical forces that have given rise to the internal architecture of the bone, so that the structure of the bone should indicate the common situations of the fracture. And it has been shown above that the lower half of the bone is the weaker, and fracture occurs here in no less

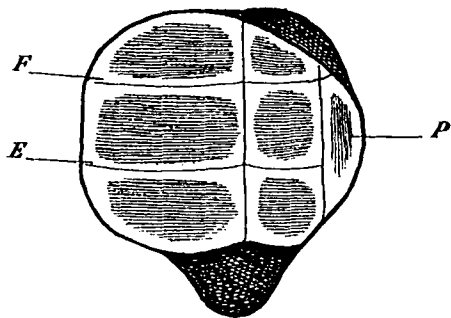


FIG. 5.—Showing facets on patella (after Macalister's "Anatomy"). *P*, area of permanent contact; *F*, flexion line, forming lower limit of flexion area; *E*, extension line, forming upper limit of extension area.

than 83 to 84 per cent. of cases. The structure of a quadrupedal patella goes hand in hand with the possibility of fracture. In this case the pressure lines extend from end to end of the section, showing that it is supported throughout its length by the femur, and, as has been shown, no case has been yet recorded of fracture having occurred through indirect violence (*loc. cit.*).

Besides the structures of the bone there is a still more important factor in localizing the situation of the line of fracture by indirect violence. This is the degree to which the knee is flexed at the time of the accident. As is well known, the articular surface is subdivided by a vertical ridge into internal

the new projectiles is due to this, that in the old, owing to the larger surface of impact, their larger normal calibre, and the greater frequency of their accidental deformation, more favorable conditions were created for the extension to the tissues through which they passed of their destructive effects. On the other hand, the notably greater velocity at near distances of the new projectiles is not sufficient to compensate for the inferior wounding power due to their smaller calibre and freedom from deformation."

It is now evident, from abundant experience, that the surgery of the new projectile is of a simpler and more hopeful character than that which attached to the old, large-calibred, soft projectiles. The changes wrought in military affairs by the new arms are rather of a strategic than of a surgical character.

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A MANUAL OF SURGICAL TREATMENT. By W. WATSON CHEYNE and F. F. BUYHARD. In seven volumes. Vol. III. Pp. 305, with 100 illustrations.

The third volume of this work (see *ANNALS OF SURGERY*, April, 1900) is devoted entirely to the surgery of the osseous system,—fractures, diseases of bone, and amputations.

This section of the manual is very good, and must prove of great practical value. As in the preceding volumes, there is still some tendency to dwell rather too much on certain old-fashioned apparatus and procedures, while some valuable "modern" methods are either treated too briefly or not at all. Although the X-rays belong properly to a treatise on diagnosis, it is surprising that this adjuvant to treatment fails of mention in this work.

The direct fixation of fractures by operative interference is considered very fully. It is rather to be regretted that the methods of pegging, wiring, etc., are so well illustrated and described, as they give the tyro a false impression of the useful-

of fractures occur at or below the middle of the bone, and of these about half (Hamilton says more than half) occur below the centre, *i.e.*, when joint is presumably slightly flexed. On inquiry into the records, oblique fractures are few, and this may be partly accounted for by the fact that small degrees of obliquity are easily overlooked clinically. Hamilton's observations being made by one man are of particular value, and he found only four cases of marked obliquity out of 127, approximately 3.2 per cent. From the St. Thomas's cases, this would appear a good deal too low; but I avoid making a

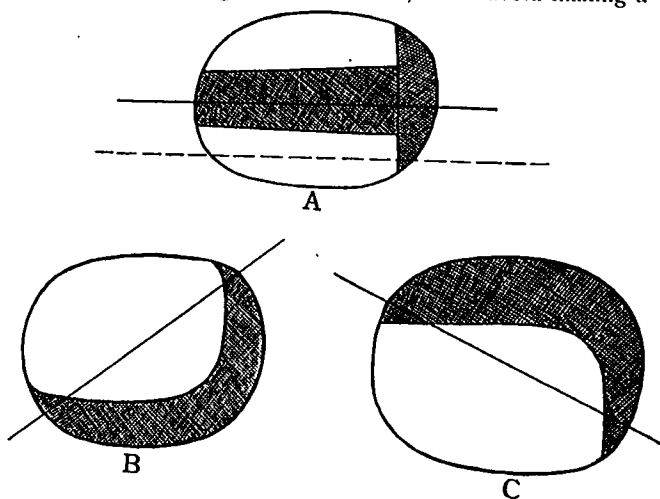


FIG. 6.—Diagram showing oblique fractures.

guess at the percentage, especially as our figures are complicated by many personal equations. At any rate, it may be argued that oblique fractures are far fewer than would be expected from a study of the mechanics of the region. Koffmann (*Deutsche med. Wochenschrift*, No. 43, p. 685, 1898) records a case of oblique fracture, and says that they are comparatively rare. He also quotes two cases of Baker, "Fractures of the Patella," and one of Tresonet (*Gazette des Hôp.*, Paris, No. 12, 1881). Powers, in the *ANNALS OF SURGERY*,

July, 1898, says that the usual direction of the obliquity is from above downward, outward, and inward, *i.e.*, the knee is fully flexed. From the St. Thomas's sources, I am inclined to agree with him. The insertion of the vastus internus into the upper and inner quadrant of the patella gives a slightly inward pull to the line of action of the resultant of the quadriceps, which will naturally lead to an obliquity of the fracture

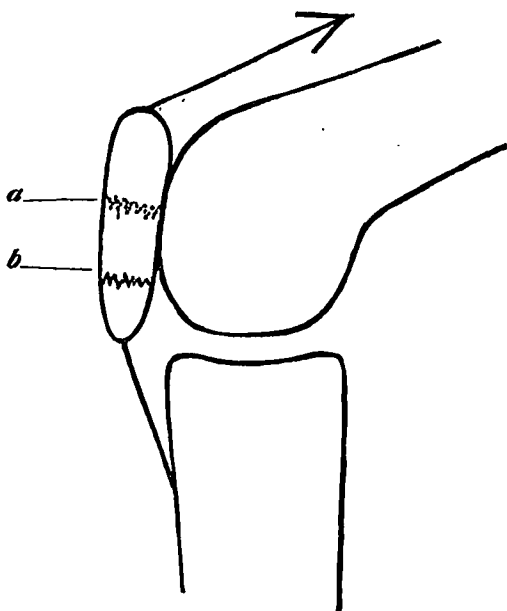


FIG. 7.—Diagram showing "contact" fracture, *a*, and non-contact, *b*.

line. This will be from above downward and without inward, agreeing with what Powers has said.

In the above, fracture at the point of contact alone has been considered. When a stick is broken across the knee, the fracture starts opposite the point of contact. In a few cases the patella fractures so low down that the break is extra-articular, "osseously" speaking, alone. These have obviously

been other than contact fractures, for the breach has occurred below the point of contact. Again, when the knee is only slightly flexed, the quadriceps has comparatively little mechanical advantage for fracture as it has when the knee is fully flexed. Hence, although by far the majority of the fractures occur during slight or semi-flexion, the muscles act relatively at a mechanical disadvantage. From consideration of the bony

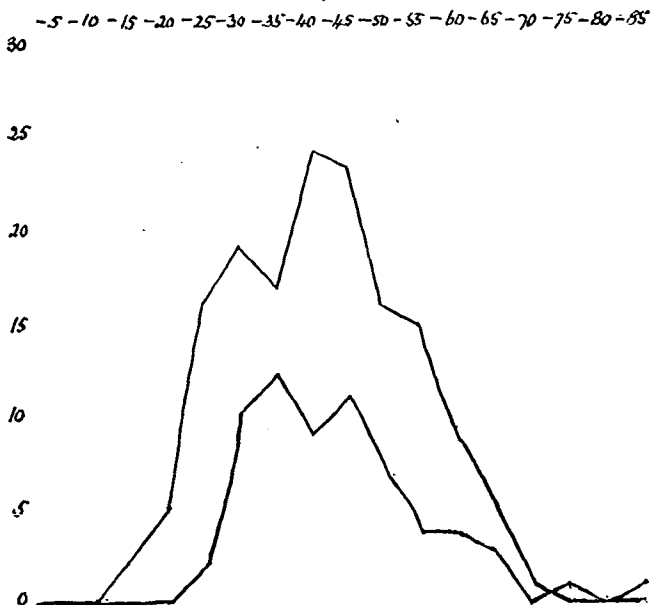


FIG. 8.—Age curves for fracture of the patella. Upper line represents male and lower line female.

structure, it was seen that the lower half of the patella was distinctly weaker than the upper; and it may be argued that the bone may give way at the weakest point which is not the contact-point. The direction of the line of such non-contact fractures will be transverse. In this way the comparative rarity of oblique fractures, or, better, markedly oblique fractures, may be explained. Such fractures are, on account of

the weakness of the lower end of the bone, far most likely to occur here. A similar fracture might occur close to the upper end of the bone, but this will be very rare.

In the course of my examinations of the St. Thomas's notes, I have noted certain facts which, though not perhaps of much value, are worthy of record and add to the completeness of this paper.

The total number of fractures admitted during the ten years was 272, and, according to the definition adopted, 254 were due to indirect violence and 18 due to direct violence. This gives the practical proportion of 14 to 1. Hamilton, for 127 (*i.e.*, half the cases from St. Thomas's cases), gives the proportion of approximately 7 to 1, or just half the proportion. In the cases I have used, I have examined the history of the accident, and have used my own judgment, so excluding as far as possible other personal equations. This is an infinitely higher proportion than is the case for the other leg bones which I also carefully worked out for the years 1892-1899 inclusively. For the femur the relation was 6.2 indirect to one direct, and for the leg bones 3.3 indirect to one direct. This extraordinary liability of the patella to suffer from indirect violence is obviously explained by the fact that it lies low on the condyles, over a functionally active joint, and must run great risks. The following shows the approximate frequency of direct and indirect fractures of the lower limb:

Patella, relation, 14 indirect to 1 direct. Femur, relation, 6.2 indirect to 1 direct. Leg bones, relation, 3.3 indirect to 1 direct.

Of the 254 cases of fracture by indirect violence, 198 occurred in males and 75 in females, giving the proportions of 2.7 males to one female, or in percentages 73 and 27. Professor Anderson (*loc. cit.*), from statistics gathered by Mr. Milton, states that fracture of the patella is relatively commoner in women than men as compared with other fractures of the leg. In consequence, observing the same precautions as regards indirect violence, I worked out the data. For the femur I obtained the result of 1.8 males to 1 female, or 64.2 per cent.

and 35.8 per cent., and for the leg bones 2.2 to 1, or 67.8 and 32.2 per cent.

Proportion of indirect violence fractures: Patella, male, 2.7; female, 1. Percentages, male, 75; female, 27.

Femur, male, 1.8; female, 1. Percentages, male, 64; female, 36.

Leg, male, 2.2; female, 1. Percentages, male, 68; female, 32.

This table shows that fractures of the patella are less common in females than males in a ratio greater than is the case with other fractures of the lower limb. They are really relatively most common in males for the patella and in females for the femur.

These figures are the more remarkable as, with Professor Anderson, no distinction was made between fractures due to direct and indirect violence, but all were added together, men suffering more from direct violence fractures than women.

With respect to age, the diagram (Fig. 8) shows curves corresponding to the number of cases occurring in each five years of life. The male curve starts between the years of 10 and 15 with two cases, and between 15 and 20 five cases. At the corresponding ages no cases occurred in females. From this point onward the male curve rises to a summit at 25 to 30, makes a small dip from 30 to 35, and reaches its maximum at 35 to 40, remaining nearly as high from 40 to 45. After this it steadily declines, reaching the base-line at 70 to 75, one case alone occurred after this from 80 to 85. The female curve, as has been mentioned, does not rise from the base-line until the ages of 20 to 25, when two cases occurred. It now rapidly rises to its maximum between the ages of 30 to 35 and to a second summit between 40 to 45, the base-line being regained at 65 to 70, after which one case occurred between the ages of 70 to 75.

It will be noticed that the male period of fracture precedes that of the female by a decade and lasts five years after that of the latter. Also that in the male the increase is more rapid,

and the first maximum attained five years before and the second five after the female. The oldest case occurred in a man some ten years older than the oldest woman.

A curve plotted from Hamilton's figures of both sexes (123 cases) begins at the same age as the male curve and rises extremely rapidly to a summit between the ages of 20 to 30 and then falls steadily and rapidly to the base-line. It differs from the St. Thomas's figures in the comparative variety of fractures from 35 to 45, which form the St. Thomas's maximum.

As a minor point, it may be mentioned that 58.2 per cent. occurred on the right side and 41.8 on the left. In only two out of 254 was the lesion bilateral, *i.e.*, about .8 per cent. Hamilton records no bilateral lesion, and, to show the futility of the "side" statistics, his are approximately 30 per cent. for the right and 70 per cent. for the left.

Refracture.—It is a matter of common knowledge that the patella is not infrequently refractured. During the period for which I examined the St. Thomas's records, I found, out of a total of 254 cases, 33 cases of refracture and 3 in which the patella of the opposite side had been previously broken. The latter cases are more rightly refractures in the individual. The figures give the percentage of 13.5 for refracture and 1.1 per cent. for fracture of the opposite bone. In speaking of refracture, I have confined my attention to cases which have resulted from indirect violence, and so far as is ascertainable also to the primary accident. Hamilton, among 127 cases, found 5 cases of previous fracture of the opposite patella, yielding an approximate percentage of 4, which is higher than the St. Thomas's. Comparing the percentage of refracture of the patella with that of the other leg bones for indirect violence, the result for the femur was found to be 1.6 per cent. and for the leg bones .7 per cent. The patella is then rebroken about nine times more frequently than the femur, and nineteen times more frequently than the leg bones. This liability to refracture is explained by its mechanical conditions, being situated over an actively functional joint, and also to two other conditions which have resulted from the adoption of the up-

right position, viz., an atrophic condition of the bone and its comparatively low situation on the femoral condyles due to the relatively short ligamentum patellæ. The conditions are naturally similar to those which have led to its original fracture. The question which naturally arises from this is, Does previous fracture leave any predisposition to refracture behind it? It is impossible to answer this directly, and consequently one is forced to a somewhat round-about method.

Osseous union as a result of the operation of wiring seems now to be held to give the best results, and this point has been most recently advocated by Powers after an examination of 711 cases (ANNALS OF SURGERY, July, 1898). In this process the best that can be hoped for is that the bone is returned to its normal shape and size; its strength somewhat doubtfully added to by the presence of the wire. As the fracture in the majority of instances (84 per cent.) lies about or below the centre of the bone, the wire connects a stronger and a weaker portion of the patella, and may occupy the insidious position of a piece of new cloth in an old garment. The above takes the view that the union is perfect and osseous. The next case to be considered is when short and strong fibrous union has occurred. In this case the length of the patella is increased, and in consequence there is greater liability to fracture across the femoral condyles. The fact that the fibrous union may allow of slight movement of the fragments on each other will, to a slight degree only, militate against this. In cases of larger fibrous union the movement of the fragments on each other is much increased, and therefore the liability to refracture may be less, but the additional danger of tearing of the fibrous union becomes greater. From *a priori* reasons it may be expected that refracture of the bone is most likely to occur after short fibrous or osseous union, whilst with progressive increase of the length of the union liability to refracture decreases and to rupture of the union increases.

In some cases osseous union seems to have occurred after a primitively fibrous union and left the patella much increased in length. Details of such cases are difficult to get, but Dr.

Henry (*American Journal of Medical Science*, 1899, p. 183) has fully recorded one. The first fracture occurred about the lower third of the bone, and was not wired; the second fracture occurred at the upper third. A skiagraph taken after the second fracture showed both fractures, the first apparently having united by fibrous and subsequently osseous union. The tilting of the lower fragment, as frequently occurs, happened in the first injury, and can be seen in the altered shape of the bone as indicated in the skiagraph. The length of the two fragments together measures three and one-quarter inches, and must have greatly conduced to the second injury, which occurred above the primary fracture and eight months afterwards.

Stumpf ("Inaugural Dissertation," Berlin, 1894), out of twenty-eight cases of fracture of the patella, came across nine cases of refracture, seven of which were bony and two in which the union had ruptured. As I have been unable to consult the original, details as to previous treatment could not be obtained. Bégonin and Anderodius (*Gaz. des Hôp.*, Paris, 1897) quote a number of cases by Ham, Brummen, and Lavise, besides their own, to show that refracture is commoner after treatment by massage than otherwise. This method usually yields short and strong fibrous union. Crickx, quoted by them, gives some very interesting figures; out of thirty-one cases treated by the Dutch method of massage he found 25 per cent. of refractures. Analyzing 249 cases treated by "other and older methods," a percentage of refracture of thirteen was obtained. As in other literature, it was not definitely stated whether the refracture was in the bone or the fibrous union. The most recent reference is that of Powers (*loc. cit.*), who states that a refracture is less frequent after wiring than after fibrous union. He gives references to the only cases of refracture that he could find, five in number. The percentages of refracture vary in the literature from 13 to 25 (St. Thomas's, 13.5). So far as can be ascertained, no attempt was made to separate fractures due to indirect from those due to direct violence.

From the St. Thomas's Hospital records details of thirty cases of refracture could be obtained. Of these eleven occurred after wiring and nineteen after other methods. Of the eleven that followed wiring, in five the situation of the refracture is stated, and in all it occurred at the same place as did the original injury. In three of these, which occurred ten days, twelve days, and two months after leaving hospital, it is specially stated that the wires were untwisted or drawn out. On the nineteen cases following fibrous union, in eleven the following details could be ascertained. In five the refracture was above the union, in two it was below, and in four it was through the same interval, *i.e.*, rupture of union. In secondary fractures after fibrous union, bony refractures are more common than rupture of the union, and occurs most commonly in the upper fragment. The latter point is easily understood, as the upper fragment is usually the larger, and with short fibrous union is far more likely to be broken, and hence, perhaps, the high rate of refracture obtained by Crickx after the Dutch or massage treatment. It may also be formulated that the lower the situation of the primary fracture the greater is the liability to a refracture. As the second fracture is more commonly above the primary, greater flexion of the knee must probably occur in the former than in the latter accident. It was impossible to make out the influence of the length of the fibrous union in these few cases, but it seems most likely, as has been suggested above, that the longer the union the less is the liability to refracture of the bone.

The time after the primary injury at which the secondary fracture occurred differs in cases submitted to wiring and other methods. To the St. Thomas's cases have been added those obtained from the literature that have occurred after wiring.

After wiring: Months, $1\frac{1}{4}$, $1\frac{1}{2}$, 2, $2\frac{1}{2}$, 3, 3, 3, 6, 6, 7, 8, 9; years, 1, 1, 2, 3, 7.

After other methods: Months, 4, 4; years, 1, $1\frac{1}{2}$, 2, $3\frac{1}{2}$, 4, 4, 5, 6, 7, $11\frac{1}{2}$, 18, 31.

After wiring, the second injury is most likely to happen

within the first few months or a year; in the other cases only after a year or more. After wiring, in the earliest two cases, the second injury was compound. These were the only two cases of compound refracture.

In the face of eleven cases of refracture occurring in the practice of one hospital within the space of a few years, Powers' statement of its rarity must be received as doubtful.

As the bone is not unfrequently refractured in the same individual, the following statistics are given showing these points:

Four times fractured in two cases; three times fractured in three cases; two times fractured in twenty-eight cases; one fracture of other patella, three cases.

It will be seen from the above that two fractures of the same bone are far the most common, and, through the smallness of the resulting fragments and the mobility resulting from the fibrous unions, further refractures are comparatively uncommon. No case in which wiring was performed presented itself with a third fracture. The fact that refracture of the same bone is more common than that of the opposite side indicates that some local predisposing condition results from the primary fracture. The patella had been also broken twice in two other cases admitted for recent fractures of femur and tibia and fibula respectively. Both were males, and are not included in the above list. Were they included, the percentage of refracture would rise to nearly 15.

Comminution resulting from indirect violence is obviously rare. One case occurred in which the lower fragment was split by an oblique fracture into two pieces.

As an uncommon cause of refracture may be quoted a case mentioned by Clutton (*St. Thomas's Hospital Reports*, 1895, p. 122). The cause which predisposed to the second fracture was adhesion of the patella to the femur as a result of the primary injury.

Of the thirty-six cases of refracture, thirty-two were of males and four of females, giving the proportion of 7.7 to 1, or 88.5 per cent. to 11.5 per cent. The corresponding figures for

primary fracture were 2.7 to 1, or 73 per cent. and 27 per cent. The proportion of males has increased in refracture, as might be expected.

The side affected can be of little importance. As the right is affected in primary fractures in the proportion of 58.2 per cent. to 41.8 per cent., in the left it would be expected that there would be a slight increase of the proportion of "rights" over that of "lefts." This is quite true, the actual figures being 60.7 per cent. and 39.3 per cent. respectively.

The age of refractures yields a very interesting curve in that its maxima occur just about five years after those of fracture, agreeing nicely with what has been said of the time of recurrence of refracture, *i.e.*, almost always within four years. By gauging proportions, it would seem that the younger the primary fracture occurs the more likely is a secondary fracture to occur, and that fractures occurring after fifty run a proportionately less liability to refracture. This certainly seems to suggest that vigor of body has to do with the case.

The ages of the four females were 20 to 25, 25 to 30, 35 to 40, and 45 to 50, in whom one refracture occurred.

In conclusion, I should like to make a suggestion as to the reason, or one of the reasons, of the failure of ossification to extend into even short fibrous unions. As the patella is a sesamoid bone, it differs from other bones in that it is not surrounded by a periosteum. In consequence of this, the osteogenetic powers must be comparatively small, and so bony union will not occur unless there is close approximation of the fragments.